

**NRC-CNRC**

Challenge program

# Materials for clean fuels



Material innovation for a cleaner, more sustainable  
Canadian energy and chemical industry



National Research  
Council Canada

Conseil national de  
recherches Canada

Canada 

# Developing transformative technologies to sustainably transition Canada's energy and chemical industries to a low-carbon economy



**The Materials for Clean Fuels Challenge program is a 7-year \$57M collaborative research program to develop new technologies to decarbonize Canada's oil & gas and petrochemical sectors.**

It has been tremendously rewarding to build the foundation of a new program at the National Research Council of Canada (NRC) poised to unlock disruptive technologies to sustainably transform Canada's oil and gas and petrochemical industries.

We developed collaborative research projects with world-leading academics and small and medium-sized enterprises (SMEs) in Canada and abroad.

Our program has 3 thrusts — **carbon dioxide (CO<sub>2</sub>) conversion, hydrogen (H<sub>2</sub>) production, and AI-accelerated materials discovery.**

CO<sub>2</sub> conversion will focus on developing new catalyst materials that can efficiently convert captured CO<sub>2</sub> (either from the air or from industrial flue) into renewable fuels and chemical feedstocks such as syngas and ethylene.

H<sub>2</sub> production will support new technologies, such as water electrolysis and methane pyrolysis, that can produce H<sub>2</sub> for industrial use while emitting less CO<sub>2</sub> than the industry standard — steam methane reforming.

AI-accelerated materials discovery will combine robotics, artificial intelligence and high-throughput experimentation to accelerate the discovery of new catalyst materials.

The NRC is building materials acceleration platforms (MAPs) — robotic and AI enabled “self-driving labs” to enable this vision. These activities will be housed at a brand new facility in Mississauga — the first NRC research presence in the Greater Toronto Area.

To date, we have developed over 20 collaborative projects with 15 universities and start-up companies in Canada and abroad (US, Germany, and the UK) with more currently under development. Building talented multi-disciplinary teams is crucial to the translation and impact of these promising technologies.

We are ready to make an impact and strengthen Canada's leadership position in this exciting area of clean tech.





## Program overview

### Why we exist

Canada needs to reduce 716 megatons of carbon dioxide emissions per year to reach its goal of net-zero emissions by 2050. Electrification and energy efficiency alone is not enough to meet our targets. Scalable technologies to produce zero-emission industrial chemicals and transportation fuels do not currently exist.

### What we are aiming to do

The mission-driven Materials for Clean Fuels (MCF) Challenge program is focused on advancing high-risk, high-reward technologies to produce feedstock chemicals and fuels from air and water rather than from fossil-based resources.

Working with the best in Canada from academia and industry, it will catalyze development of materials for renewably-powered CO<sub>2</sub> conversion and hydrogen production using artificial intelligence and robotics to accelerate this discovery.

### Our research activities

- Artificial intelligence and robotics for materials discovery
- Catalyst design and synthesis
- Membrane design and synthesis
- Device development and prototyping
- Advanced characterization and spectroscopy
- Technoeconomics and lifecycle assessments

### Program timeline

The program will run for 7 years from 2019-2026 and follows a funnel approach whereby the number of projects in the program decreases and the amount of investment per project increases over time. The goal is to advance technologies as fast as possible from a low technology readiness level (TRL) to a high technology readiness level.

Expression of interest calls to collaborate will occur before each phase with academics or SMEs eligible for collaboration funding.

### Research facilities

Research will be conducted at the NRC's facilities across Canada.

**Vancouver** is home to the NRC's Hydrogen Laboratory and will play a pivotal role in the development of electrochemical device development.

**Edmonton** hosts the NRC's Nanotechnology Laboratory with advanced microscopes and unique molecular modelling.

**Ottawa** is where the NRC's materials characterization, life-cycle and technoeconomic analyses, and artificial intelligence expertise lies.

**Montreal** is focused on bio-refining and will be where the majority of our hybrid electro/biocatalysis work will be performed.

**Mississauga** is the site of our robotic materials acceleration platforms or "self-driving labs".

Taken together, the NRC's unique and specialized facilities host all the tools and expertise needed for breakthrough innovation, materials discovery, prototyping, and demonstration.

### NRC Mississauga

*Pictured above*

A large focus of this brand new advanced materials facility will be on developing new clean energy materials and acting as a catalyst to accelerate the development of advanced materials technologies and their commercialization in disruptive new products.

## Research activities



Artificial Intelligence



Catalysts



Membranes



Prototypes

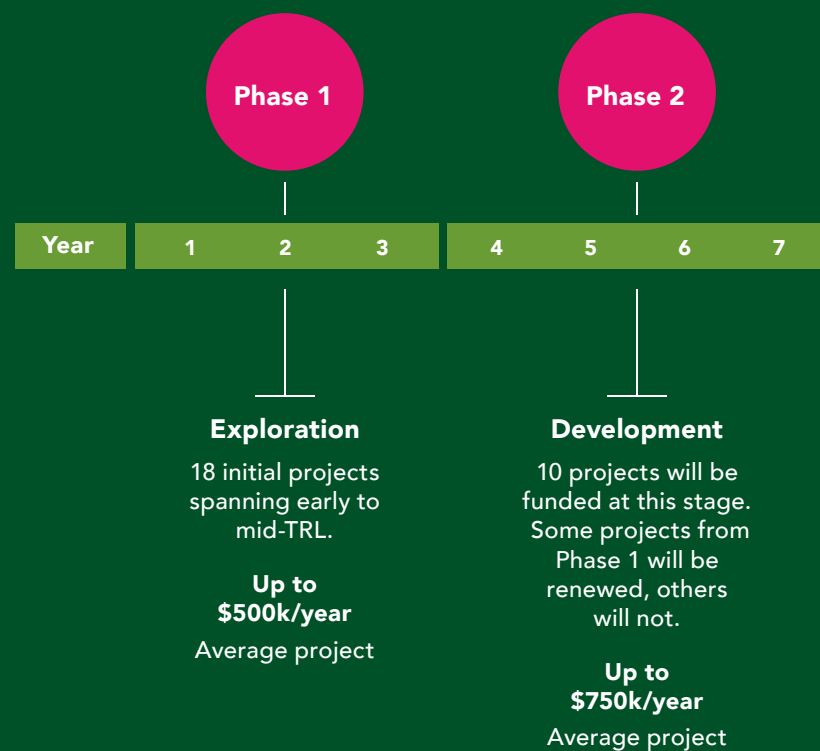


Characterization



Technoeconomics

## Timeline



## Program team

The NRC's experts in clean technology lead the Materials for Clean Fuels Challenge program



Martin Tyrawsky  
Acting Program Director



Russell Girard  
Challenge Officer



Claudie Roy  
CO<sub>2</sub> Thrust Leader



Nima Shaigan  
H<sub>2</sub> Thrust Leader



Farid Bensebaa  
TEA/LCA Thrust Leader



Isaac Tamblyn  
AI Thrust Leader

## Advisory committee

The program is guided by a committee of clean tech professionals representing the NRC's important stakeholders

Randy Cortright (Chair)  
Senior Research Advisor National Renewable Energy Laboratory (NREL)

Walter Cicha  
Industrial Technology Advisor  
NRC Industrial Research Assistance Program (NRC IRAP)

Fiona Cunningham  
Director of Innovation · CIFAR

Monica Gattinger  
Director, Institute of Science, Society, and Policy · University of Ottawa

Mark Kirby  
President & CEO, Canadian Hydrogen and Fuel Cell Association

Mike Lyne  
Director of Operations · Suncor

Fiona Zuzarte  
Science and Technology Advisor  
Natural Resources Canada

Barry MacDougall  
Senior Science Advisor · NRC (retired)

## Collaborators

The NRC works with academic institutions, startups and research organizations around the world to solve tough problems

### Canadian

Ekona  
Ionomr Innovations  
Miru Smart Technologies  
McMaster University  
McGill University  
Natural Resources Canada  
Polytechnique Montréal  
Simon Fraser University  
Université de Sherbrooke  
University of Alberta  
University of British Columbia  
University of Calgary  
University of Ottawa  
University of Toronto  
University of Waterloo

### International

Forschungszentrum Jülich  
Helmholtz Institute Erlangen-Nürnberg  
Karlsruhe Institute of Technology  
Imperial College London  
RWTH Aachen University  
University of Michigan  
Carnegie Mellon University

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## Phase 2 call

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The NRC will be launching a phase 2 call in spring of 2022. We are seeking collaborators to help advance technology in CO<sub>2</sub> conversion, H<sub>2</sub> production, and AI-accelerated materials discovery.

### ●●● Contact

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Materials for Clean Fuels Challenge program

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[canada.ca/nrc-challenge-programs](https://canada.ca/nrc-challenge-programs)

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